Interface Document
for the
VMS
(Vehicle Management System)

PRELIMINARY

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Overview:

The VMS is the interface between the AC150 drive system/charging system, Batteries, and the driver. It is also the computer that controls the battery charging. It is currently programmed to end charge based on module voltage or pack voltage which is normal for most lead acid batteries. Consult your battery manufacturer for their requirements. Contact ACP for information about tailoring your system for specific charging needs.

The driver interfaces are composed of two LCD control panels, up to 10 analog meters (optional), and a 28-30 LED battery display (optional).

The two LCD control panels, called the Battery Optimizer Display and the Energy Status Display, each have a back lit LCD display and four buttons for changing menus and adjusting set points. The Energy Status panel also has an eight LED bar graph to display SOC (state of charge).

The VMS has 10 outputs to drive analog meters. We recommend that the battery current, pack voltage, motor temperature and PEU temperature be displayed with analog meters. See DAC output section for a full list of outputs.

The optional 28-30 LED display informs the driver in real time of which battery modules are above 14v or below 11v (to use this feature you must be using the BatOpt or VTM battery monitoring devices).

If not using BatOpts or VTMs many features of the VMS will not be available. We strongly recommend using some sort of battery module monitoring to prevent damage to the batteries.

The VMS allows the operator to:

1. Adjust the recharge settings for battery current, line current, or battery pack voltage.
2. Adjust the battery cooling fan threshold, battery over temperature limit (when using the BatOpt or VTM monitors and a BFC (Fan driver module)).
3. Set Battery Cycling mode for discharging first into then from the AC line for Battery heath information (when using the BatOpts or VTMs).
4. Turn on UPS mode to charge another vehicle or power some 50Hz/60Hz AC device using the vehicles charge port (not recommended in systems without battery module monitoring).
5. Turn on the High voltage supply to the cabin heater PTCs (see the PEU J2 documentation) using an external switch input to the VMS.
6. Utilize the Parking brake drive speed limit in case the parking brake is left on.
7. Receive audible warnings if any battery module is out of set limits (when using the BatOpt or VTM monitors).
8. Turn charge miser on/off. Charge miser improves charging efficiency at low power levels.
9. Log battery and system information with a standard RS232 capable computer.

The VMS displays give information on:

1. All the battery temperatures and voltages (when using the BatOpts or VTMs).
2. Overall driving efficiency and efficiency during trip mode.
3. Total Mileage and trip mileage, the motor RPM, and average speed.
4. Latitude, longitude and self setting clock (when using optional GPS module)
5. SOC (state of charge), AH and kWh.
6. Motor temperature.
7. PEU Temperature.
8. Battery pack voltage.
9. Battery, hybrid and high voltage accessory currents.
10. AC Line RMS voltage and current.

BOD (Battery optimizer display)

LEDs

HIGH/LOW MODULE	lights if battery module voltage is less than 11V or greater than 14V.
FAN ON	lights if any battery temp is above fan turn on threshold.
HEAT ON	lights if any battery module heater is on.
CHARGE DISABLE	lights if pack charge is disabled due to timeout or overtemp

BOD screens:

Splash Screen

```
      +--------------------+
      ¦AC Propulsion       ¦
      ¦Copyright 2002      ¦ Third line:
      ¦11/14/02 01.08 01 30¦ Software date and version vehicle type
      ¦ _.-=+~^|^~+=-._    ¦ Number of batteries.
      +--------------------+
```

Dataloss Screen

```
      +--------------------+
      ¦Dataloss:Check      ¦
      ¦3 AAs in Dash       ¦ Replace three AA batteries by VMS.
      ¦                    ¦
      ¦                    ¦
      +--------------------+
```

Display screens - Select key cycles through, Menu key to access settings

Module Voltage Bargraph:

```
+--------------------+
¦13579135791357  11.5¦  Autoranges off high or low module
¦_-_-_--_---_-_      ¦  as a function of current
¦_-_-_--_---_-_      ¦ +/- keys shift range for ~5 seconds
¦24680246802468  9.5 ¦ to view out of range values
+--------------------+
```

Module Temperature Bargraph:

```
+--------------------+
¦13579135791357   40C¦
¦_-_-_--_---_-_      ¦  +/- switch between 8 and 16C range
¦_-_-_--_---_-_      ¦  autoscales off max temp for upper limit.
¦24680246802468   32C¦
+--------------------+
```

Module Detail Display:

```
+--------------------+
¦Address=1 Ready     ¦  +/- selects module #
¦Voltage=11.68 12.1  ¦  Displays module voltage, Ave module voltage,
¦Batt Temp=35 Max=40 ¦  module temperature and max module temperature.
¦AhSet=0 T=12.06     ¦
+--------------------+
```

Module Charge/Heat Command display:

```
+--------------------+
¦13579135791357      ¦  Only shown in versions with BatOpt battery
¦~~~~~~~~~~~~~~      ¦  modules.
¦CH_~~~~~~~~~~~      ¦  Idicates which modules are being commanded to
¦C=Charge H=Heat _=CH¦  heat and or charge.
+--------------------+
```

Min/Max Module display:

```
+--------------------+
¦MinMod= 11.6V #01   ¦
¦MaxMod= 12.7V #19   ¦  Fourth line is blank at start, on error
¦MaxTemp=40C 12.3V Av¦  logs lowest module voltage if error lasts
¦#18=8.1 D19.8A 12.0V¦  for at lest 5 seconds.
+--------------------+
```

Battery and Line Current/Voltage display:

```
+--------------------+
¦Meas.Line=208V 18A  ¦ Measured line Voltage and current.
¦I_Sys=D19.8A 358V   ¦ Measured System DC Current and voltage.
¦IH=D0.0A IA=D0.0A   ¦ Measured Hybrid and Auxiliary currents.
¦Motor=25C PEU=50C   ¦ Measured temperature for motor and PEU.
+--------------------+
```

Amphour and watthour summary display:

```
+--------------------+
¦AHD=4.8811 1.7864KWH¦ Discharged Battery Amp-Hour kilowatt-hour
¦AHC=.0000  .0000KWH ¦ Charged    Battery Amp-Hour kilowatt-hour
¦Hyb=.0000  .0000KWH ¦ Net Hybrid         Amp-Hour kilowatt-hour
¦Aux=.0000  .0000KWH ¦ Net Aux HV         Amp-Hour kilowatt-hour
+--------------------+
```

Positional display: (Present only for GPS option)

```
+--------------------+
¦Lat=34.2011 Mode=3D ¦  Latitude in Degrees and mode of satellite fix.
¦Long=118.1718       ¦  Longitude in degrees.
¦Ele=228m            ¦  Elevation in meters from sea level.
¦Spd=0.0m/s Hd=320.1°¦  Speed meters per second, heading degrees
+--------------------+  clockwise from north.
```

Time display:

```
+--------------------+
¦ *  *  *   *  *  *  ¦  Large 24 hour clock display.
¦ *  **** * ****  * 5¦
¦ *     *      *  * 6¦
¦ *     * *    *  *  ¦
+--------------------+
```

****

Menu Screens - Select key to pick variable, +/- keys alter, Menu key to next menu (variables that are changeable are shown here in bold).

****

Alter Mode variable, charge/discharge/UPS/Deepcycle/V2g, to switch between submenu

Recharge Control Menu Sub: CHARGE mode

```
+--------------------+
¦Mode: CHARGE    Off ¦
¦ILine:29  Miser:On  ¦  Line current limit, charge miser feature.
¦IBatt:05  VBHi:420  ¦  Battery current and voltage limits.
¦No Grid D2          ¦  Connection Status.
+--------------------+
```

Recharge Control Menu Sub: Discharge mode

```
+--------------------+
¦Mode: DISCHARGE Off ¦
¦ILine:29  Dis_AH:00 ¦  Line current limit.
¦IBatt:05  VBLo:300  ¦  Battery current and voltage limits.
¦No Grid D2          ¦  Connection Status.
+--------------------+
```

Recharge Control Menu Sub: UPS mode

```
+--------------------+
¦Mode: UPS_      Off ¦
¦VOLTS:120 Dis_AH:00 ¦  Desired output Voltage(RMS),
¦IBatt:05  VBLo:300  ¦  Current and pack voltage discharge limits.
¦No Grid D2          ¦  Connection Status.
+--------------------+
```

Recharge Control Menu Sub: Diagnostic mode

```
+--------------------+
¦Mode: DEEPCYCLE Off ¦  Discharge from present SOC then full charge.
¦IBDis:20 IBChg:20   ¦  Set battery discharge and charge rates
¦ModLo:10.81 VBLo:300¦  Module and pack Discharge Limits
¦Chg_AH:00  Dis_AH:00¦  Active tracking during cycle and logs to EEPROM
+--------------------+  see Diagnostic screen.
```

Recharge Control Menu Sub: V2G mode

```
+--------------------+
¦Mode: VehToGrid Off ¦
¦HiEnd:005 LoEnd:020 ¦  State of charge range at end of V2G
¦MinAH:030 EndIn:255H¦  Lowest allowed State of Charge, Hours till end
¦NetAH down from CAP ¦  Hi,Low,Min. are AH down from full.
+--------------------+
```

****

Time set screen:

```
+--------------------+
¦Set Time: 14:41:56  ¦  Note if time is adjusted the adjustment
¦2002 November 05    ¦  takes effect after the menu button is pushed.
¦Tuesday             ¦  (If GPS option is used only hour offset
¦Press Menu when done¦  from UTC is adjustable)
+--------------------+
```

Battery heat cooling menu:

Batt Heat:**35** Fan:**40** ChargeOff@:**52C** Mode: **0 No Heat**	Battery heating set point (for BatOpt only). Battery cooling set point. Battery over temp charge shutdown set point. Battery heating mode set (for BatOpt only).

****

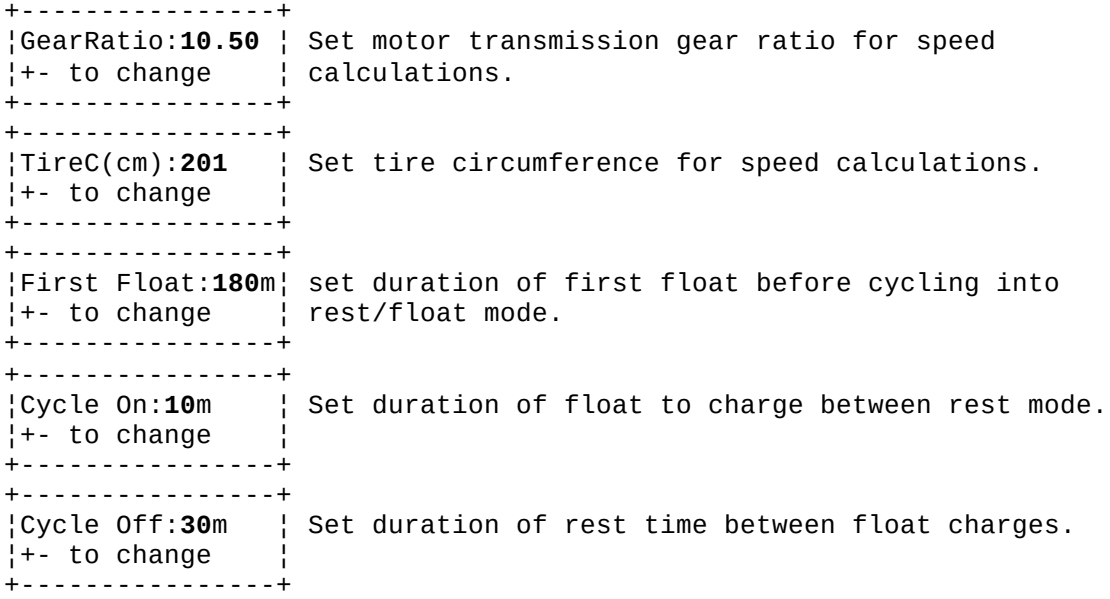
Factory mode menu screens – restricted access:
(Enter factory mode from Battery heat cooling menu press and holt +/- buttons)

AutoSet:**Y** Dif:**.18V** Drive ^ Recharge -v HighBankLim: **15.56V** LowBankLim: **13.56V**	AutoSet (for BatOpts only) turns chargers on if (Vave-Vmod) is greater then Dif: setpoint. Highest battery limit during charging. Lowest battery when BatOpts are bank switching.
00000000000000 1 **00000000000000** Sel AHSet= Press Sel to Set AH	Only shown in versions with BatOpt battery modules. Manually turn on/off BatOpt chargers.
Rlim=419v 259=DLim **15.56** 13.31 **9.0** rP:**48** 12288 dP:**100** rI:**20** 000000 dI:**200**	Drive limits based on battery pack. Drive limits based on High battery module. Drive limits based on Low battery module Integral/proportional terms for reg/drive.
10/31/02 First Fault 14AH 390A 5025RPM #28 34C 9.0v 38:30C 9.5V Av	Battery Fault logging screen. First and worst for last four on periods. Diagnostic cycle logs for last four cycles.
   Crimp: **off**	Battery monitor crimp test screen (For use with BatOpt modules only)
370V 13.2 12.9 08 27 65000 0 13.2N S5A 0 4.25D 000 15.6 _L 000020CAFFFF00000000	Debugging screen.

****

ESD (Energy status display) screens:

ESD (Energy status display) screens (continued):


GearRatio:10.50
+- to change
Set motor transmission gear ratio for speed calculations.
TireC(cm):201
+- to change
Set tire circumference for speed calculations.
First Float:180m
+- to change
set duration of first float before cycling into rest/float mode.
Cycle On:10m
+- to change
Set duration of float to charge between rest mode.
Cycle Off:30m
+- to change
Set duration of rest time between float charges.

Meter DAC outputs (J19):

The Analog outputs are intended to drive analog meters by selecting a header resistor on HA to supply the correct current to the meter. HA1 through HA8 are positive 0 to 5V output only and are current protected to 5mA, we recommend meters with less then 1mA full scale. HA9 and HA10 are bi-directional output –11V to +11V and are current limited to 11mA we recommend using bi-directional meters with less then 1mA full scale.

Header Position	**J15 Position**	**Function**	**Scaling**
HA1	6	Line Voltage	1V/100Vrms
HA2	7	Line Current	2V/100Arms
HA3	5	Speedo	2.5V/12,000 RPM
HA4	3	Bus Voltage	0-5V = 240 – 440V
HA5	1	Hybrid Current	1V/20A
HA6	2	PEU temperature	2V/100C
HA7	4	Motor temperature	2V/100C
HA8	9	Hybrid temperature	2V/100C
HA9	10	Bus Current (D600A to C350A)	1V/100A (-6.5V to +3.5V)
HA10	8	Extra	+11V to –11V (12Bit)
	11	Ground	
	12	Ground	

Charging Cord ID and UPS cord ID (Not implemented):

Charging cords can utilize an ID resistor to limit the maximum current into or out of the AC line. Charge cords typically have male ends on them and are unsafe to use with the PEU in UPS mode therefore UPS cords need to have an ID resistor that identifies it and also set the maximum allowed current through it. The ID resistor wires from the charge port should have both wires fused and a 15-20V transient voltage suppressor or bi-directional zener diode between fuses on the vehicle. The two wires go to J6-5 and J6-6 on the VMS.

The values (+/-4%) for the ID resistors are the following:

Charge and Discharge			**UPS mode**		
Line Current	ID resistor		AC current limit	ID resistor	
0A RMS	<11K and >9.2K		0A RMS	<11K and >9.2K	
0A RMS	11K		0A RMS	9.2K	
10A RMS	13.6K		10A RMS	7.4K	
15A RMS	15.2K		15A RMS	6.66K	
20A RMS	16.8K		20A RMS	6.04K	
25A RMS	18.9K		25A RMS	5.36K	
30A RMS	21.4K		30A RMS	4.74K	
40A RMS	27.5K		40A RMS	3.71K	
50A RMS	36.3K		50A RMS	2.81K	
60A RMS	52.1K		60A RMS	1.97K	
70A RMS	81.0K		70A RMS	1.28K	
80A RMS	160K		80A RMS	660 ohm	
84A RMS	273.3K		84A RMS	408 ohm	
10A RMS	>274K (also no ID resistor)		0A RMS	<408 ohm	

Power requirements for VMS (J20):

		MIN	TYP	MAX	UNITS
INPUT VOLTAGE		11	13.5	16	V

INPUT CURRENT	Sleep		1.5	10	‘mA’
INPUT CURRENT	Active		310	600	‘mA’

RS232 Datalogger output to laptop:

The laptop output, J3, is supplied for data logging it outputs a time index stamp, Pack voltage, System current, Hybrid port current, Aux highvoltage current, RPM, Battery module voltages and temperatures, battery charger heater status, Net AH, Net KWh, GPS information *(elevation, mode, latitude, longitude , ele, speed)*. The baud rate is 19.2K, 8N1 with no hardware or software flow control.

Optional Labview helper programs (you must have or buy Labview to run these):

T0LOG12.VI

Realtime display of streaming Hex data from VMS J3 serial port, logs data file

RAW2CSV.VI

Converts and optionally reduces raw data format to Comma Separated Values for spreadsheet processing, also playback data. 10:1 expansion of raw file.

FAKELOI.VI

Simulates serial data stream from PEU, allowing laptop to emulate drive

Connectors:

J1 PEU **9 pin DB Male** (Connects to PEU J1b with standard 9 pin serial cable)

1	2	3	5	6	8	9
Neutral	RX	TX	GND	E_ON	CMD	Tach. pulses

J2 TRAILER **9 pin DB Male** (Matting connector is standard 9 pin DB female)

2	3	5
RX	TX	GND

J3 SERIAL OUT **9pin DB Female (**Laptop) (Matting connector is standard 9 pin DB male)

2	3	4	5	9
TX	RX	DTR	GND	Tach. out

J5 Battery backup 1x2 **2mm** (Matting connector: DigiKey part# H2083-ND)

1	**2**
+4.5v to 5v	**GND**

J6 general I/O connector for charging 1x6 **2mm** (Matting connector: DigiKey part# H2087-ND)

1	**2**	**3**	**4**	**5**	**6**
J7-4	**J7-2**	**J7-3**		**Cord ID**	**GND**

Extra carrier board bergs 2 rows of 10pos. 2.0 in. apart

J7

1	**GND**	**PWR**
2	**J6-2**	**I/O**
3	**J6-3**	**I/O**
4	**J6-1**	**I/O**
5		
6	**CS#2(RD6)**	**SPI**
7	**UPS disable**	
8	**Key**	
9	**TX**	**RS232**
10	**RX**	**RS232**

J16

1	**GND**	**PWR**
2	**J14-12**	**I/Os**
3	**SDI**	**SPI**
4	**SCK**	**SPI**
5	**SDO**	**SPI**
6	**-12V switched**	**PWR**
7	**Key**	
8	**J14-9**	**I/Os**
9	**+12Vunsw**	**PWR**
10	**+12V switched**	**PWR**

J8 Fans 2(PWM), temp. sense(2), heaters 2(I/Os) 2x4 **2mm** (Matting connector**:** DigiKey part# H2022-ND)

1PP2	2PP0	3RA2	4PB4	5PAD4	6PAD5	7	8
FAN2	FAN1	DI/O#1	DI/O#2	Temp+1	Temp+2	Temp -1	Temp -2

J9 PIC Debugger 2x4 Berg

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
MCLR WITH PULLUP	**RB6**	**RB3**	**RB7**	**+5V**	**GND**	**KEY**	**N/C**

J10 Display connector (20 pin IDC)

1	D0 (LCD)	(PA0)
2	D1 (LCD)	(PA1)
3	D2 (LCD)	(PA2)
4	D3 (LCD)	(PA3)
5	D4 (LCD)	(PA4)
6	D5 (LCD)	(PA5)
7	D6 (LCD)	(PA6)
8	D7 (LCD)	(PA7)
9	E.S.D select	(PB7)
10	Reg. Select (LCD)	(PB0)
11	Strobe for LCD	Not used
12	B.O.D select	(PB6)
13	*<Extra>*	
14	-5V for LCD	
15	*Button sense (sw1 on BOD)*	Remote turn on of VMS. (RB4)
16	12V supply	
17	Ground	
18	MOSI for PIC transfers	Data to display (PA0)
19	Clock for PIC transfers	(PB3)
20	MISO for PIC transfers	Data from display (PT0)

J11 Buzzer 1x3 **2mm** (Matting connector: DigiKey part# H2084-ND)

1	**2**	**3**
+12v	**KEY**	**switched GND**

J12 Debugger 2x4 Berg for 68HC12

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
BKGD	**VDD**	**KEY**	**RESET**	**VPP**	**GND**	**+12V**	**N/C**

J13 Optional GPS 1x3 **2mm**

1	2	3	4	5	6
+5Vsw	N/C	To pad	To pad	Tx to HC	GND

J14 Optional 1x5 Berg

1	2	3	4	5
GND	Key	Ca	Cb	+5v

J15 Optional 1x6 **2mm (Not used)**

1	2	3	4	5	6

J16 See J7

J17 LED matrix 1x7 **2mm** (Matting connector: DigiKey part# H2088-ND)

1	2	3	4	5	6	7
Cb	SCLK	CS	+12Vsw2	SDO	+5V sw2	GND

J18 general I/O connector 2x7 **2mm** (Matting connector: DigiKey part# H2088-ND)

1	2RC2	3	4RA4	5RA1	6	7RA1
AI 1-	DO/PWM	AI 1-	DO	AI 2+	DI	AI 2-

8PA0	9J11-8	10	11	12J11-2	13	14
DI	EXTRA	DI	GND	EXTRA	Pawl lock	Pawl unlock

J19 Dash meters **(see DAC output section)** 2x6 **2mm** (Matting connector: DigiKey part# H2024-ND)

1	2	3	4	5	6	7	8 12BIT	9	10 12BIT	11	12
IAPU	TPEU	VBUSS	TMOT	SPEEDO	VLINE	ILINE	EXTRA	TAPU	IBUSS	GND	GND
HA5	HA6	HA4	HA7	HA3	HA1	HA2	HA10	HA8	HA9		

J20 Power connector 1x4 **2mm** (Matting connector: DigiKey part# H2085-ND)

1	2	3	4
GND	GND	+12Vunsw	+12Vunsw

J21 Battery Communication 2x3 **3mm (Molex)** (Matting connector: DigiKey part# WM1785-ND)

1 Receive	2Receive	3	4	5Transmit	6Transmit
Cb	Cb	Extra pad	Extra pad	Ca	Ca

Extra crimps for the 2mm connectors are:

For single row: DigiKey part# H2138-ND

For double row: DigiKey part# H2139-ND

Extra crimps for the 3mm Molex connector:

DigiKey part# WM1837-ND